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ORIGINAL ARTICLE

Application of Arbuscular Mycorrhizal Fungi on Zinc and Iron Concentration in Wheat under Cadmium Stress

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KEYWORDS

Arbuscular mycorrhizal;
Bio-fertilizer;
Cadmium;
Soil contaminate Wheat

ABSTRACT: For evaluate the application of a bio-fertilizer on zinc and iron concentration in wheat, under cadmium st greenhouse experiment was conducted in factorial design with three replications. Treatments included Arbuscular Mycc levels (Control, *Glomus mosseae* and *Glomus intraradices*) and cadmium with six levels (0, 5, 10, 20,40 and 80 mg.kg measured data showed that the effects of treatments were significant on zinc and iron concentration. Arbuscular mycoı fungi increasing zinc and iron concentration in plant. *Glomus intraradices* species increased zinc concentration in sho root % 252 and %222, respectively. But *Glomus mosseae* species increased iron concentration in shoot and root % 1 %170, respectively.

INTRODUCTION

Iron is an essential micronutrient for almost all living organisms because of it plays critical role in metabolic processes such as DNA synthesis, respiration, and photosynthesis [1]. Zinc is essential for the growth in animals, human beings, and plants it is vital to the crop nutrition as required in various enzymatic reactions, metabolic processes, and oxidation reduction reactions [2]. Ecosystem has been contaminated with heavy metals due to various natural anthropogenic activities. [3]. Continuous use of chemical fertilizer leads to deterioration accumulation of heavy metals in plant tissues [4]. Bio-fertilizers provide plant nutrition and protecting the environment degradation [5]. Arbuscular mycorrhiza fungi have a symbiotic relationship with the roots of 80% plant species [6]. There is a symbiotic relationship between mycorrhizal fungi and the roots of higher plants [7]. Mycorrhizal fungi could increase nutrients uptake and reduce environmental stresses of plants such as low temperature stress, drought and salt stress [8]. The role of arbuscular mycorrhiza fungi has been found to increase the resistance of plants to heavy metals 9]. Arbuscular mycorrhizal fungi (AMF) can improve soil structure, increases species diversity and comfort uptake of nutrients from their host plant [10]. Ninety percent of the plants need nutrients such as phosphorus and zinc supplied by mycorrhizal fungi [11]. For evaluate the effect of arbuscular mycorrhiza fungi (*Glomus mossea* and *Glomus intraradices*) on zinc and iron concentration in wheat, under cadmium stress a greenhouse experiment was conducted in Fars Education Center of Jahad-e-Agriculture- Aliabad kamin.

MATERIALS AND METHODS

Greenhouse pot culture experiments were conducted in Fars Education Center of Jahad-e-Agriculture- Aliabad kamin. Treatments included arbuscular mycorrhizal fungi with three levels (Control, *Glomus mossea* and *Glomus intraradices*) and cadmium with six levels (0, 5, 10, 20 ,40 and 80 mg.kg^{-1}). The measured data showed

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that the effects of treatments were significant on concentration of zinc and iron. Each treatment was replicated three times. The mycorrhizal inoculant was prepared by the Plant Protection Clinic in Hamedan – Iran. Soil was prepared of arable land of depth of 0-30 cm in Fars Education Center of Jahad-e-Agriculture-Aliabad kamin, after the complete analysis of soil and obtains chemical and physical properties in the laboratory (Table1), Soil was passed by 2 mm sieve. Then 10 kg of soil was weight for each pot and eventually soil contaminated by cadmium. Cadmium sulfate salt used in this experiment, for contaminate soil samples different amounts of salts dissolved in distilled water and sprayed on the soil, after drying the soil, weighed 100 grams of mycorrhizal fungi and mixed with the soil. After mixing the soil with mycorrhizal fungi, Put the soil in pots and then wheat seeds was cultivated. In this study the 10 seeds were planted in each pot. The distilled water was used for irrigation. After the complete growth plant, measured Zinc and Iron concentration in root and shoot of wheat plant.

Nitrogen was measured by kjeldal. Phosphorus and potassium of soil were measured with spectrophotometer and Flame Photometer respectively. Iron and Zinc concentrations were measured by atomic absorption spectrophotometer Model 1973- Varian AA 20.

SAS (version 9) and MSTATC (version 2.10) Software was used for analysis data, and obtained variance analysis tables. Mean comparison of different treatments was conducted by Duncan test.

Table1. Chemical and physical properties of soil.

Soil depth	**EC**	**pH**	**Soil texture**	**N**	**P**	**K**	**Cd**	**Fe**	**Mn**
Cm	dsm^{-1}			%			ppm		
0-30	3.4	7.6	Silty loam	0.2	16	244	1.4	1.1	0.8

RESULTS AND DISCUSSION

According to Table 2, the effect of cadmium concentration in soil on iron and zinc concentration in plant was significant ($p<0.001$). With increasing cadmium concentrations in soil, iron and zinc concentration reduced in root and shoot plant (Figures 1 and 2). Concentration of 80 mg.kg cadmium in soil reduced zinc concentration in shoot and roots 70.6% and 71.3% and iron concentration reduced in shoot and root 58.3% and 65.6% respectively .It has been reported that plants inoculated with mycorrhizal fungi increased plants root system and also increased uptake of soil nutrients such as phosphorus, zinc and copper [12]. Reported arbuscular mycorrhiza fungi increased the iron concentration in the plant organs when nutrients were not added to the soil [13].

Table 2. Analysis of variance the traits measured

Variation Resource	**df**	**Mean Square**			
		Fe $_{Root}$	**Fe $_{shoot}$**	**Zn $_{Root}$**	**Zn $_{shoot}$**
Cadmium	5	10425.2^{**}	12498.700^{**}	80540.31^{*}	11702.967^{**}
Mycorrhiza	2	18790^{**}	24696^{**}	34640.28^{**}	42691.167^{**}
Cadmium× Mycorrhiza	10	$468.97^{N.s}$	$509.200^{N.s}$	$3.54^{N.s}$	$3.87^{N.s}$
Error	36	4.87	5.556	3.58	5.63
Coefficient of Variation (%)	-	5.9	7.8	9.7	6.4

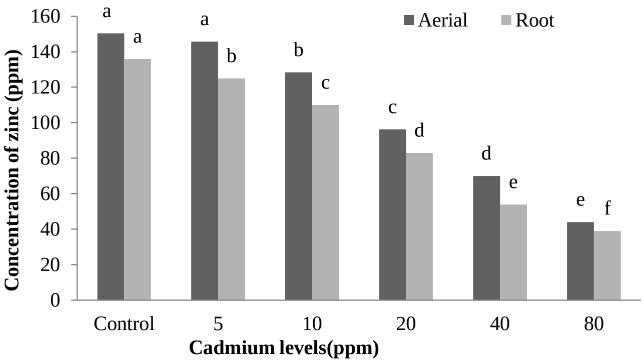

Figure1. The effect of cadmium levels on zinc concentration

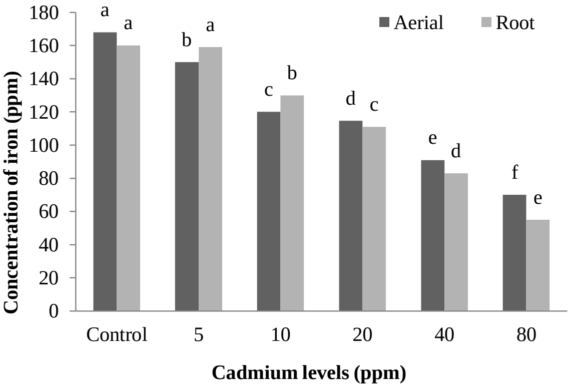

Figure 2. The effect of cadmium levels on iron concentration

According to Table 2, the effect of arbuscular mycorrhiza fungi on zinc and iron concentration was significant ($p<0.001$). The highest concentration of zinc observed from the *G. intraradices* species (Figures 3 and 4). G. *intraradices* species increased zinc concentration in shoot and root % 252 and %222, repectively. And G. *mossea* species increased iron concentration in shoot and root % 148 and %170 respectively. Nutrient uptakes of mycorrhizal plants were higher when compared with non-mycorrhizal fungi. Copper, zinc and iron nutrient mobility in soils very low. Mycorrhizal fungi increase the uptake of these elements in the soil [14].

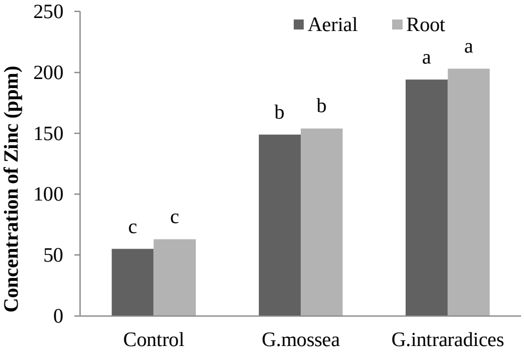

Figure 3. The effect of mycorrhiza fungi on zinc concentration

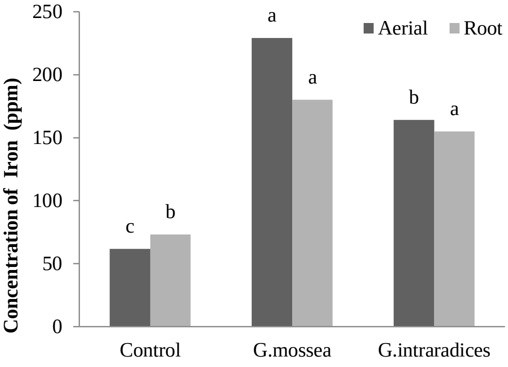

Figure 4. The effect of mycorrhiza fungi on iron concentration

Mycorrhiza symbiosis with the roots of plants is useful. One of these advantages, reducing the concentration of heavy metals in the host plant [15]. Some reports indicate that arbuscular mycorrhiza fungi increase the tolerance of plants in soils contaminated with heavy metals; the main mechanism to increase plant tolerance is binding of heavy metals in ther hizosphere with mycorrhizal fungi hyphae [16].

CONCLUSIONS

Results of this research showed that concentration of the iron and zinc were higher in plants inoculated with mycorrhizal fungi compared to the control. With increasing levels of cadmium in the soil, nutrient uptake by plants was reduced. It appears that cadmium combined with iron and zinc in soil and around of the root plant. So iron and zinc concentration reduced in plant. Arbuscular mycorrhizal fungi increasing zinc and iron concentration in plant. *G. intraradices* species and *G. mossea* species increased zinc and iron concentration in wheat plant respectively. G. *intraradices* species increased zinc concentration in shoot and root % 252 and %222, repectively. And G. *mossea* species increased iron concentration in shoot and root % 148 and %170 respectively.

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